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BIRDS COLLECTED DURING THE WHITNEY SOUTH SEA EXPEDITION. XXIX¹

NOTES ON THE GENUS *PETROICA*

BY ERNST MAYR

The present paper contains a continuation of the revisions of Polynesian genera. New investigations were undertaken to clarify the occurrence of unusual immature and adult plumages.

PETROICA Swainson

Petroica SWAINSON, 1829, Zool. Illustr., (2) I, p. 39. Type (by monotypy): *Muscicapa multicolor* Gmelin.

GENERIC CHARACTERS.—Small and medium-sized flycatchers with a relatively small bill which at the nostrils is about as wide as high; tarsi rather weak; wing and tail short; plumage soft and fluffy; adult males usually brightly colored.

This genus lives, with several species or subgenera, in Australia, Tasmania, and New Zealand. Only one species, *Petroica multicolor* (Gmelin), reaches the Polynesian region.² This species appears to be absent on New Caledonia but otherwise has the typical distribution of an Australo-Polynesian species. It has several races on the Australian continent and the neighboring islands (Kangaroo Island and Tasmania), but it also reaches far into Polynesia. The geographical variation of size and coloration is surprisingly small in this vast area and is easily surpassed by the individual variation of plumages.

The correct interpretation of these plumages is the greatest problem in this species, and although I believe I have succeeded in bringing some light into this matter, there still remain some unsolved questions.

Petroica multicolor

RANGE.—Eastern and southern Australia, Kangaroo Island, Tasmania, Norfolk Island, New Hebrides, Banks Islands, Fiji Islands, Samoa, and Solomon Islands.

¹Previous papers in this series comprise American Museum Novitates, Nos. 115, 124, 149, 322, 337, 350, 356, 364, 365, 370, 419, 469, 486, 488, 489, 502, 504, 516, 520, 522, 531, 590, 609, 628, 651, 665, 666, and 709.

²For a map see: Mitt. Zool. Mus. Berlin, XIX (1933), p. 313.

***Petroica multicolor multicolor* (Gmelin)**

Muscicapa multicolor GMELIN,¹ 1789, 'Syst. Nat.,' I, part 2, p. 944, Norfolk Island.

ADULT MALE.—Upper throat and head black, except for a large white spot on the forehead and anterior part of the crown; back, scapulars, rump, and upper tail-coverts black; lower throat, breast, and abdomen reddish scarlet; crissum and under tail-coverts white, thighs black; tail entirely black, the outer tail-feathers with light edges; wing black, inner middle and greater upper wing-coverts white or partly white; axillaries and some of the under wing-coverts whitish; inconspicuous white band across the inner webs of the secondaries.

Iris brown, bill and feet black.

IMMATURE MALE (first-year plumage):

PHASE a.—Upper side dull cinnamon-brown, in some specimens distinctly washed with rufous, in others more olivaceous or grayish; forehead slightly lighter; sides of head mottled buffy, brownish and grayish; circumocular feathers buff; chin and upper throat whitish; wing brown, edges of upper wing-coverts ochraceous buff; ochraceous tawny bar across the outer webs of the secondaries and inner primaries; buffy white bar across the under side of the wing much broader and more conspicuous than in the adult; tail dark brown, tail-feathers with light brown edges; outermost tail-feather with considerable white on the outer web and on the tip; lower throat, breast, and upper abdomen scarlet, strongly mixed with cinnamonaceous on the breast, sides of breast and flanks.

PHASE b.—Similar to phase *a*, but under side orange scarlet, instead of scarlet.

PHASE c.—Similar to phase *a*, but under side light cadmium yellow, instead of orange or scarlet.

PHASE d.—Similar to phase *a*, but under side without any lipochromes; breast and sides washed with grayish cinnamon.

There are in the Whitney collection two specimens of phase *a*, two of phase *b*, three of phase *c*, and one of phase *d*.

ADULT FEMALE.—Very similar to phase *b* of the immature males, but with much less lipochrome on the under side.

IMMATURE FEMALE.—Similar to the adult female, but with still less lipochrome.

Tarsus, 22–23.5 (23.0); culmen, 15.5–17.0 (16.1) (in adult males).

	WING	TAIL
4 ♂ ad.	69–70 (69.8)	52 (52.0)
8 ♂ imm.	65–69 (66.6)	48–52 (50.1)
3 ♀	67–69 (67.8)	50–51 (50.6)

RANGE.—Norfolk Island, Australian Sea.

The Norfolk Island bird is in many respects a very distinct subspecies. Its bill is long, slender, and laterally compressed, while the other forms of the species have a more typical flycatcher bill. Compared with the other oceanic subspecies it differs in the large size of the frontal white patch, in the almost complete absence of white on wing and tail, and in the wide extent of the scarlet area on the under surface.

¹For synonyms see Mathews, 1930, 'Syst. Av. Austr.,' p. 446.

I have treated in detail the various color phases of the immature male since they seem to cast some light on the relationship of the yellow, orange, and red pigment. It confirms the idea of their close relationship already held for some time by the biochemists and the more progressive taxonomists.

The material is not sufficiently extensive to decide with absolute certainty whether or not all of the eight immature males are in exactly the same plumage. There is a possibility that one or two are in a retarded adult plumage, but only in one bird (phase *a*) are the testes indicated as large. However, this bird has the skull not yet ossified, and therefore I doubt the correctness of the indication on the label.

***Petroica multicolor pusilla* Peale**

Petroica pusilla PEALE, 1848, 'U. S. Explor. Exped.,' Birds, p. 93, Pl. xxv, fig. 3, Upolu, Samoa Islands.

ADULT MALE.—Crown, back, scapulars, rump, upper tail-coverts, sides of head, lores, ear-coverts, and upper throat (sooty) black; large patch on forehead white; wing-feathers and tail-feathers brownish black; median upper wing-coverts and inner greater coverts white with black bases, some of the secondaries (fourth to sixth) with narrow white or buffy edges; seventh to ninth primary with small white spot on the outer web near the base; white bar across inner web of secondaries and inner primaries; outermost (sixth) pair of tail-feathers buffy with blackish brown area on the base extending along the inner web, and a similar area in the lower third of the outer web; fifth and fourth pair also with more or less extended areas of buffy white; axillaries and part of under wing-coverts white, lesser under wing-coverts blackish; lower throat, breast, and upper belly pale vermillion to pale scarlet; lower flanks, lower belly, and under tail-coverts white or buffy white; thighs blackish.

Iris brown, bill black, feet brown.

IMMATURE MALE (first-year plumage).—Similar to the adult male, but retains tail and wing of the nestling plumage, except the tertials and some of the inner upper wing-coverts.

NESTLING MALE.—Upper side smoky brown, feathers on the crown with buffy shaft-streaks, and on the back and rump sometimes more sooty; feathers of throat and breast with gray bases, light centers, and blackish or brownish edges; abdomen whitish or pale ochraceous; wing blackish brown, upper wing-coverts and secondaries with ochraceous tips; white bar across the outside of the wing scarcely developed; tail blackish brown and buffy, pattern about as in adult birds.

ADULT FEMALE.—Similar to adult male, but blackish parts more sooty; white patch on forehead and on wing smaller; ochraceous edges on secondaries more pronounced; chin and upper throat mottled grayish, not black; reddish tones on under parts less intense and more restricted to the breast; lower abdomen whitish or buffy, sides of breast often grayish.

IMMATURE FEMALE (first-year plumage).—Similar to the adult female, retains tail and wing of the nestling plumage, except the tertials and some of the inner upper

wing-coverts; usually also less red on the under parts and the white frontal patch smaller.

NESTLING FEMALE.—Very similar to male nestling, but usually lighter, particularly on the under parts.

Tarsus (in adult males), 17–18; culmen, 13.5–14.5 mm.

	WING	TAIL
Upolu ♂ ad.	60–63 (61.1)	37–39 (38.2)
♀ ad.	58–61 (59.2)	36–40 (37.8)
Savaii ♂ ad.	59–63 (61.0)	37–40 (38.8)
♀ ad.	58–61 (59.1)	36–39 (37.7)

RANGE.—Upolu and Savaii, Samoa Islands.

Specimens from Upolu and Savaii agree with each other in every respect. There is, however, a considerable degree of individual variation, particularly in the females. The red of the under side is sometimes more reddish scarlet, sometimes more orange-scarlet; the gray of the throat is sometimes more blackish, sometimes mixed with whitish; the lower belly is sometimes pure white, sometimes with an ochraceous tinge; the same is true for the white marks on wing and tail, which are sometimes pure and in other specimens with a definite ochraceous tinge. These differences are of an individual nature and have no geographical significance.

Some of the females from Savaii have yellowish feet and yellowish-brown mandibles. I do not know whether this has any significance in regard to the age of these specimens, since all their other characters are typically adult.

***Petroica multicolor kleinschmidti* Finsch**

Petroica kleinschmidti FINSCH, 1875, Proc. Zool. Soc. London, p. 643, Viti Levu, Fiji Islands [description of female].

ADULT MALE.—Very similar to *pusilla* Peale, but upper side slightly deeper black, white spot on forehead considerably larger, white bar on under side of wing broader and more extended; white bar across the upper side of the wing usually also more developed; white patch on the wing possibly larger.

ADULT FEMALE.—Entirely different from that of *pusilla*; upper side not sooty black, but dark slate-colored with a brownish wash; forehead lighter, but not white; lores and eye-ring whitish or light gray; upper and middle throat whitish with a buffy, grayish, or pink wash, not dark grayish; breast peach-red, paler and more pinkish, less scarlet than in *pusilla*; extension of reddish zone on under side apparently more restricted; flanks, belly, crissum, and under tail-coverts whitish; wings and tail lighter, less blackish; whitish buff or ochraceous bar across the wing and edges of secondaries broader.

IMMATURE MALE (first-year plumage).—Very variable, but generally similar to the adult female; red on under side more extended; tail and wing from the nestling plumage.

IMMATURE FEMALE (first-year plumage).—Similar to adult female, but with nestling wing and tail; red restricted to middle of breast, sides of breast and flanks washed with brownish gray; mandible and feet yellowish or brown.

NESTLING.—Indistinguishable from that of *pusilla*.

Tarsus (in adult males), 16.5–17.5; culmen, 13–14 mm.

	WING	TAIL
♂	61–65 (61.9)	38–41 (39.7)
♀	59–60 (59.5)	38–39 (38.3)

RANGE.—Viti Levu and Vanua Levu, Fiji Islands.

This subspecies, which is very well marked in the female plumage, has been considered a synonym of *pusilla* by the majority of the authors. There are only a few specimens in collections, and even the Whitney Expedition did not get a complete series. It is therefore not possible to classify with certainty all of the various plumages occurring in this subspecies.

Freshly molted males (May and June) have the under parts pinkish scarlet, while birds from October, December, and January, in a more worn plumage, have a more orange-scarlet coloration. It is however doubtful whether this difference can always be attributed to wear and bleaching. A series from Samoa (see p. 4), collected within one month, also shows considerable variation.

Two of the males wear unusual plumages. One is from Viti Levu (No. 251449, collected in May) and one from Vanua Levu (No. 251445, collected in February). Both have small testes and the skulls apparently not quite ossified. However, they are quite different from typical immature males. They are almost as extensively red underneath as an adult male, but the throat is neither whitish nor black, but of a blackish gray mixed with reddish; the upper side is of a smoky gray, but badly worn; and the white spots on forehead and wing are fully developed; the wing-coverts are without light tips, and the primaries are shaped very much as in an adult bird. It is hard to say whether these are immature birds in a progressive phase, or, which is more likely, adult birds in a retarded plumage.

***Petroica multicolor becki*, new subspecies**

TYPE.—No. 251416, Amer. Mus. Nat. Hist.; ♀ ad., Kandavu Island, Fiji Islands; November 3, 1924; R. H. Beck and J. G. Correia.

ADULT MALE.—Very similar to that of *kleinschmidti*, but red on flanks reaching farther down; middle of throat frequently mixed with reddish; upper side not so deeply black, buffy or whitish edges on the secondaries much narrower.

ADULT FEMALE AND IMMATURE BIRDS.—Similar to specimens of *kleinschmidti* in the equivalent plumage, but having the upper side lighter, and with a warmer,

more cinnamomeous, less slaty tinge; sides of face and breast also more brownish; edges of upper wing-coverts, secondaries, and bar across the wing more ochraceous, less buffy white; throat, sides of breast, flanks, and sometimes even the crissum distinctly washed with ochraceous, while in *kleinschmidti* these parts are either whitish, grayish, or only faintly tinged with ochraceous; red on under side farther extended on the middle of the throat and down the flanks; the red on the under side is more salmon-red, less pinkish scarlet; this difference however is partly due to the condition of the plumage, most of the Kandavu birds being collected later in the season.

	WING	TAIL
11 ♂ ad.	60-64 (61.7)	38-41 (39.1)
6 ♀ ad.	56-60 (58.5)	38-39 (38.6)

RANGE.—Kandavu Island, Fiji Islands.

While working out the Casey Wood collection from the Fiji Islands, Wetmore remarked on a possible difference between Viti Levu and Kandavu birds (Ibis, 1925, p. 845). He had, however, very insufficient material and refrained therefore from the naming of the Kandavu bird. The series collected by the Whitney South Sea Expedition shows that the difference is not individual and that the Kandavu birds can be separated as a distinct subspecies from the Viti Levu birds. Wetmore's specimens, kindly loaned to me by the U. S. National Museum, fully agree with the Whitney material.

One would expect to find birds from Taviuni Island identical with Vanua Levu Island birds, in analogy with other species of Fijian birds. My material unfortunately is very insufficient, consisting of one adult female and two males in the first year plumage, but these specimens seem to be intermediate between *kleinschmidti* and *becki*, in fact in the coloration of the upper side they more closely resemble *becki*. Additional material must be examined before anything definite can be said about the systematic position of the Taviuni birds.

***Petroica multicolor ambrynsensis* Sharpe**

Petroica ambrynsensis SHARPE, 1900, Ibis, p. 341, Ambryn Island.

ADULT MALE.—Progressive type of plumage; similar to *Petroica multicolor kleinschmidti* and *pusilla*, but bill longer and more narrow; upper parts duller, not quite as pure black; light edges on secondaries very narrow or missing; bar across outer webs of primaries only indicated, or missing; white bar across the under side of the wing narrow and inconspicuous; light pattern on tail and size of white frontal patch extremely variable.

ADULT FEMALE.—Differs from females of *kleinschmidti* and *pusilla* in many ways, but approaches *becki* from Kandavu in some respects. Under side rather extensively red, reaching from the lower throat to the lower abdomen; reddish colors not pinkish, but orange-red or salmon-red; throat, sides, flanks, and sometimes also the crissum washed with ochraceous; throat strongly washed with grayish, thus

darker than in *becki*; upper side similar to that of *becki*, but darker and less sandy colored, however without the pronounced grayish tone of *kleinschmidti*; tips of feathers on forehead very light (ochraceous); white or ochraceous marks on wing, as in male, much less developed than in the Polynesian forms.

IMMATURE MALE (first-year plumage).—Indistinguishable from the adult female, possibly averaging slightly more rufous on the upper parts; under parts extremely variable, but flanks and lower belly averaging more whitish, less ochraceous; wearing a combined plumage, wings and tail belonging to the nestling plumage.

IMMATURE FEMALE (first-year plumage).—Upper parts as in the adult female, but red on under parts less extended and much paler; wings and tail immature.

NESTLING.—Similar to that of *kleinschmidti*, but slightly darker, particularly on the breast; ochraceous band across the wing, and ochraceous edges of secondaries fairly well developed.

Tarsus, 19; culmen, 13.5–14.5 mm.

		WING	TAIL
New Hebrides	3 ♂ ad.	62, 63, 65	41, 41, 45
	1 ♀ ad.	60	40
Gaua Island	7 ♂ ad.	60–63 (61.5)	41–43 (41.6)
	4 ♀ ad.	59–60 (59.8)	40–41 (40.5)

RANGE.—Tonga, Lopevi, Pauuma, Ambryn, Aoba, and Santo, New Hebrides; Meralav and Gaua Island, Banks Islands.

The original description of this form, based on a single adult and one immature male, is very scanty and does not point out any difference from *similis*. However, Sharpe mentions one character of this form, namely the reduction of the light pattern on the wing.

***Petroica multicolor similis* Gray**

Petroica similis G. R. GRAY, 1859, 'Cat. Birds Trop. Islands Pac.,' p. 15, Aneiteum, New Hebrides.

ADULT MALE.—Similar to *ambrynsensis*, but black of upper side duller, more sooty; white patch on upper wing-coverts larger; throat tending to be not pure black, but mixed with grayish brown; light bar across the outside of the wing sometimes indicated, white band across the under side of the wing slightly wider; size of white frontal patch and extent of red on flanks variable and apparently without geographical significance.

ADULT FEMALE.—Unknown.

Of three "females" in the British Museum, one (from Aneiteum) seems to be immature, and two (from Aneiteum and Tanna) seem to be young males, wrongly sexed, according to the information given to me by Mr. Kinnear. A female from Aneiteum in the Whitney Collection, also appears to be an immature male. I shall give a detailed description of this specimen.

IMMATURE MALE (first-year plumage) ? (No. 212424).—All upper parts dark grayish, with a slight olivaceous, but no rufous tinge; forehead and circumocular feathers whitish; upper tail-coverts very dark, almost sooty; chin white, throat whitish with a gray tinge; breast and upper belly pale orange-scarlet; flanks, cris-

sum and under tail-coverts white; wing fuscous, alula and primary-coverts with soft buffy tips (sign of immaturity); broad white bar across inner five primaries and across the secondaries; some of the secondaries with narrow buffy edges; inner upper wing-coverts (freshly molted) blackish with broad white tips; broad white bar across the under side of the wing; tail with an unusually large amount of white, outermost tail-feather almost completely whitish. Wing, 62; tail, 43; culmen, 14; tarsus, 19 mm.

This bird (collected in June 1926) is sexed as a female, but it seems to be an immature male in the "combined" first-year plumage. More material must be studied before it can be decided whether the unusual amount of white in this bird is abnormal, or a normal character of this subspecies. According to Kinnear (*in litt.*) there is in the British Museum a male from Aneiteum (Freeman collector) "with white throat and whitish cheeks."

RANGE.—Aneiteum, Tanna and Erromango, New Hebrides.

The above described "female" (= ? immature male) is the only specimen of this subspecies which I have examined. All the other data on this subspecies I owe to the information kindly given to me by Mr. Norman B. Kinnear. The British Museum has six birds from Aneiteum, two of which seem to be (? semi-) adult males, three immature males, and one an immature female. Besides these typical birds the British Museum has also one adult and one immature (sexed "female") male from Tanna, and one immature male from Erromango. The adult male from Tanna is the only specimen in the British Museum in which the black of the throat is not suffused with grayish.

The material thus far collected in the three southern New Hebrides is quite insufficient to decide whether or not there are any differences between the birds from the three islands. So long as there is no evidence to the contrary I regard them as identical.

***Petroica multicolor feminina*, new subspecies**

TYPE.—No. 212410, Amer. Mus. Nat. Hist.; ♂ ad.; Mai Island, New Hebrides; July 7, 1926; R. H. Beck and J. G. Correia.

ADULT MALE.—Well-developed white patch on forehead; crown brown with a pronounced vinaceous-red wash; back umber brown, lighter on the rump, and with a rather pronounced reddish-brown spot in the middle of the back; upper tail-coverts darker brown; chin whitish; upper throat whitish, feathers with pink tips; lower throat, breast, and abdomen scarlet, in some specimens darker, in others paler; sides of breast with an olivaceous-brown wash; lower flanks, crissum, and under tail-coverts white or light ochraceous; wing brown, insignificant narrow ochraceous bar across the outer webs of the three or four innermost primaries; upper wing-coverts and secondaries with dark ochraceous or rufous-brown edges; innermost upper wing-coverts occasionally edged with whitish; white bar across the under side of the wing practically obsolete; tail fuscous, with the light pattern reduced to a light area on the outer web of the outermost tail-feather.

Bill brown, base of mandible yellowish; iris and feet brown.

ADULT FEMALE.—Similar to the adult male, but upper side lighter, more cinnamonaceous, not so dark brown; feathers on forehead with buffy or pale ochraceous tips, but without a patch of white feathers; lores mottled whitish; chin and entire throat whitish with a slight grayish-brown and sometimes pinkish wash; extent of scarlet on under side reduced as compared to adult male, not reaching so far up on the throat and so far down on the flanks and belly; wing and tail very much as in the male, but female possibly with somewhat more whitish on the tail.

IMMATURE MALE (first-year plumage).—In coloration almost identical with the adult female, possibly still lighter on the upper side and on the throat; wings and tail immature; these birds are very similar to *P. m. ambryensis* in the same plumage, but lighter and more rufous cinnamon on the upper side.

IMMATURE FEMALE (first-year plumage).—Very similar to immature male, but with the reddish tones reduced; upper side practically without any reddish hue; scarlet on under side reduced to a scarlet-orange band across the breast and upper abdomen.

Culmen (in adult males), 14; tarsus, 19.

	WING	TAIL
6 ♂ ad.	63–66 (64.5)	42–46 (44.0)
5 ♂ I y.	59–63 (61.8)	41–42 (41.2)
5 ♀ ad.	60–63 (61.4)	40–43 (41.2)
4 ♀ I y.	59–61 (60.2)	40–41 (40.5)

RANGE.—Efate and Mai Islands, New Hebrides.

This new form is highly interesting since the adult plumage of the male is a retarded plumage which is very similar to that of the female. We have here a case similar to that in *Pachycephala pectoralis feminina* (see Amer. Mus. Novit., No. 486, pp. 25–27).

***Petroica multicolor soror*, new subspecies**

TYPE.—No. 212229, Amer. Mus. Nat. Hist.; ♂ ad.; Vanua Lava Island, Banks Islands; November 10, 1926; R. H. Beek and J. G. Correia.

ADULT MALE.—Very similar to that of *P. m. feminina*, and with the white patch on the forehead well pronounced, but all upper parts darker, less brownish; sides of head, wings, and tail also darker, and more fuscous, less brownish; scarlet of under side more intense and reaching higher up on the throat, grayish or grayish-brown wash on the upper breast and on the sides less pronounced; pattern on wing and tail very much as in *feminina*; innermost upper wing-coverts always edged with whitish.

ADULT FEMALE AND IMMATURES.—Differ from the equivalent plumages of *feminina* also by being darker and less brownish.

Culmen, 14–15; tarsus, 19.

	WING	TAIL
5 ♂ ad.	64–66 (65.0)	42–44 (43.4)
1 ♀ ad.	62.0	43.0

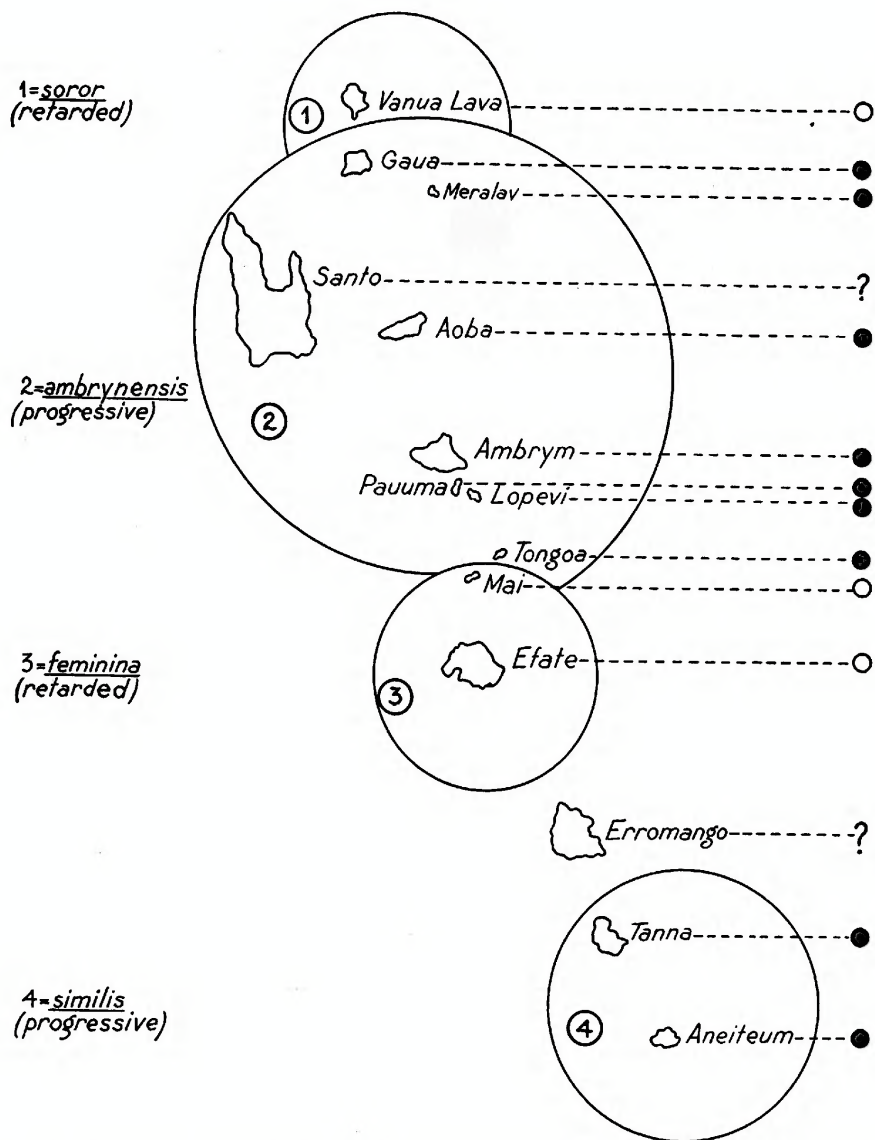


Fig. 1. Geographical distribution of the types of plumage in *Petroica multicolor* on New Hebrides and Banks Islands.

○ = plumage of adult males retarded.

● = plumage of adult males progressive.

RANGE.—Vanua Lava Island, northern Banks Islands.

This subspecies is surprisingly similar to *feminina*, although the ranges of the two forms are widely separated by *ambrynnensis*, which lives in the northern New Hebrides and southern Banks Islands. Four of the five adult males have the gonads greatly enlarged (in November). Four other males, which I consider as immature on account of pale ochraceous tips of the primary-coverts, have also enlarged testes. There is a possibility that this species begins breeding while still in the first-year plumage.

***Petroica multicolor polymorpha*, new subspecies**

TYPE.—No. 227992, Amer. Mus. Nat. Hist.; ♂ ad.; San Cristobal Island, Solomon Islands; December 13, 1929; E. Mayr, W. F. Coultas, and W. J. Eyerdam.

ADULT MALE (typical plumage).—Similar to *Petroica multicolor kleinschmidti* Finsch, but upper side apparently deeper black; white frontal patch washed with pink, particularly in its posterior portion; white patch on wing appearing larger in the examined specimens, but this probably is due to the different method of preparation; second to fifth secondary with broad white edges on the outer web, while in *kleinschmidti* the same feathers are either entirely black or have only a narrow white or buffy edge; lower flanks and crissum pure white, not with a buffy or ochraceous wash; breast and abdomen light scarlet-red.

ADULT MALE (red-headed phase).—Agrees in the coloration of back, breast, abdomen, wing, and tail with the adult male in the typical plumage, but the head has an entirely different coloration: forehead pale brown; crown brownish, more or less strongly washed with rufous-vinaceous, which sometimes obliterates the brownish tones completely; chin grayish or buffy white, upper throat reddish scarlet, middle of throat blackish, many feathers with reddish tips; lores whitish, sides of head cinnamon with a slight reddish wash.

Besides these typical adult birds in the normal black-headed and the unusual rufous-headed phase, there are a number of abnormal and immature specimens in the collection. Fortunately they were all collected during the molting season, which permits important conclusions on the sequence of plumages, but unfortunately there are no additional collections from any other season, which accounts for the small number of birds in the first year dress.

I have tried to outline a classification of the possible sequence of plumages in this species, but I have to admit frankly that I do not feel sure that I have interpreted correctly all the observed phenomena, particularly since several plumages are represented by only one specimen.

Table of Plumages and Molts of Males of *Petroica multicolor polymorpha*
as Shown by the Specimens Collected by the
Whitney South Sea Expedition

I.—NESTLING PLUMAGES AND SUBSEQUENT MOLTS

Nestlings molting into the "retarded" first-year plumage	227994 ¹
Nestlings molting into the "progressive" first-year plumage	227998 and 227999

II.—FIRST-YEAR PLUMAGES AND SUBSEQUENT MOLTS

	Black-headed phase	Rufous-headed phase
First year retarded molting into adult retarded		227993
First year retarded molting into adult progressive	? 227989	
First year progressive molting into adult progressive	228016 ? 227989	227990

III.—ADULTS PLUMAGES AND SUBSEQUENT MOLTS

	Black-headed phase	Rufous-headed phase
Adult retarded molting into adult retarded	228017	227995
Adult progressive molting into adult progressive		228015
Not molting	228001 228014	227992 227996 227997

There is no evidence in all my material for the following additional possibilities of plumage changes:

- From a progressive first-year plumage to a retarded adult plumage.
- From a retarded adult plumage to a progressive adult plumage.
- From a rufous-headed plumage to a black-headed plumage.

Description of Immature and Unusual Plumages

NESTLING MALE.—Plumage soft, downy; upper side dark cinnamon-brown, feathers with pale (buff) shaft-streaks; upper throat pale ochraceous, lower throat and breast ochraceous tawny; lower belly, flanks, and under tail-coverts whitish; tail blackish brown, outermost pair with white marks, which are more extensive than in adult; wing blackish brown; upper wing-coverts and secondaries with ochraceous-tawny tips or edges; innermost upper wing-coverts sometimes partly whitish; bar across the outer webs of primaries and secondaries white.

From the nestling plumage these birds may molt into a "retarded" or a "progressive" first-year plumage. Unfortunately the collection contains only very few birds in the first-year plumage, and I am not sure whether the descriptions reconstructed from molting specimens are entirely correct.

¹Numbers refer to the catalogue numbers of The American Museum of Natural History.

MALE (retarded first-year plumage).—Wing as in nestling. Upper side and sides of head of a uniform cinnamon brown, lighter on the forehead; chin, throat and lores whitish; breast pinkish or pale salmon-colored, washed with ochraceous, particularly on the sides.

MALE (progressive first-year plumage).—Birds in this plumage apparently have the reddish tones on the under side deeper (approaching scarlet), the back, the wings, and the tail more blackish, and (if they belong to the rufous-headed phase) the crown strongly washed with reddish. It is possible that in some cases even birds of the black-headed phase have a rufous-tinged crown in the first-year plumage (No. 228016).

This first-year plumage is apparently worn almost a full year—namely, until the beginning of the next breeding season.

MALE (black-headed adult plumage).—Most specimens in the collection are in the “progressive” plumage, described above (p. 11). However, there is one unusual bird (No. 228017) that is molting from one retarded plumage into another one. The worn plumage is rather brownish on the sides of the head, and with a distinct reddish wash on the crown; the edges of the secondaries, the light marks on the tail, and the lower belly have a marked ochraceous wash. The new feathers of the upper side are sooty or brownish black, not jet-black, and have whitish bases on the upper throat instead of being entirely black. The old wing-feathers, as well as of course the new, have all the characters of an adult condition.

MALE (rufous-headed adult plumage).—In this phase also the majority of the molting specimens is molting from one progressive plumage into another. However, the special interest afforded by this kind of molt is the fact that the birds do not change over into the black-headed phase. Once rufous-headed they always seem to remain rufous-headed.

One bird (No. 227995) is molting from a retarded plumage again into a retarded plumage. The new feathers on the head are less reddish than in a bird with a “progressive” plumage, they are more reddish brown; the feathers of the back are brownish with a reddish tinge, the upper tail-coverts and the tail blackish brown; the feathers of the throat (also the newly molted ones) are whitish with pink or ochraceous-pink tips; the breast light scarlet and the sides of the breast washed with ochraceous; the wing-feathers seem to acquire a more progressive appearance by the molt; the old wing, although adult as shown by the shape of the first primary and the lack of rufous edges on the primary-coverts, has the secondaries with ochraceous edges and the upper wing-coverts with rufous-ochraceous edges, in the new wing these feathers have whitish edges.

ADULT FEMALE (typical).—Somewhat similar to the adult male in the rufous-headed phase, but all colors less intense. Crown dull rufous brown or cinnamon brown, with a slight reddish wash; forehead lighter, some feathers with pale buffy or whitish edges; lores whitish; ear-coverts and sides of neck dull brownish; back sooty black, rarely as blackish as in an adult male, usually with a liberal admixture of brownish; no sharp line of demarcation between the brownish crown and black back, but rather a slow intergradation; coloration of throat variable, usually chin and upper throat whitish; middle of throat more grayish or with an ochraceous wash, lower throat of the same color as breast and belly; middle throat and sometimes upper throat more or less washed with pink; breast and abdomen pale scarlet or grenadine; crissum,

lower flanks, and under tail-coverts white; wing and tail as in adult males. As in some adult males the white marks in the wing of some of the females in worn plumage have an ochraceous tinge; this is likely due to discoloration since it can not be found on any newly molted feather.

ADULT FEMALE (retarded).—There is one specimen in the collection (No. 228006) which molts from the first-year plumage into an adult plumage. Only the wing is molting, while the body plumage is fresh, apparently having just completed its molt. The back in this bird is not black but (rufous) brown like the crown, but the lower back is somewhat darker; upper and middle throat white with a strong brownish wash. The brownish color of the back and the coloration of the throat cause me to regard this bird as possessing a "retarded" plumage. There are three additional females in the collection (Nos. 227991, 228009, and 228012) which show intermediate characters. The back is only partly brownish, and the brownish wash on the throat is also less pronounced.

FEMALE (first-year plumage).—Very similar to that of the male. Upper side uniform brownish, darker on lower back and rump, more rufous on the crown; sides of head cinnamon; upper and middle throat whitish, with a brownish wash on the sides; lower throat and breast pale salmon-colored; abdomen and under tail-coverts white; wing blackish, secondaries, primary-coverts, and upper wing-coverts with deep ochraceous edges or tips; a white or cinnamonaceous bar across the outer web of the five innermost primaries, a whitish bar across the base of the outer secondaries; tail blackish, most tail-feathers with small white tips; outermost pair with extended white area.

NESTLING FEMALE.—Similar to male nestling, but upper side and wing somewhat lighter and more brownish.

Culmen (in adult males), 14; tarsus, 17–18.

	WING	TAIL
7 ♂ ad.	60–63 (61.4)	39–43 (40.4)
6 ♀ ad.	60 (60.0)	40–41 (40.4)

RANGE.—San Cristobal, Solomon Islands (collected December 1929.)

***Petroica multicolor septentrionalis*, new subspecies**

TYPE.—No. 225221, Amer. Mus. Nat. Hist.; ♀ ad. (ovaries large); Bougainville Island, Solomon Islands; January 19, 1928; F. P. Drowne.

ADULT MALE.—Probably identical with the black-headed phase of *polymorpha*; the only differences seen in my specimens (reduction of pink on forehead, lighter red on under side, duller black of upper parts, ochraceous tinge on wing and crissum, and less conspicuous white on wing) are apparently caused by wear, soiling, and method of preparation. Rufous-headed phase absent.

ADULT FEMALE.—Entirely different from the adult female of *polymorpha*; rather resembling the first-year plumage of that subspecies; but differs from it in having the upper side lighter and more olivaceous cinnamon than rufous brown, in having no white in the wing (except a white bar on the under side of the wing), and in not having throat and abdomen whitish, but washed with grayish buff. The reddish colors on the under side are not restricted to the breast as in first-year birds, but reach from the

throat to the lower belly. Only the crissum and under tail-coverts are without lipochrome.

There is a great deal of individual variation in the coloration of the under side. There is every step represented from a yellow (orange buff, R. 15) to a scarlet, usually these colors are pale and not intense.

One specimen (No. 225222) wears a somewhat "progressive" plumage. The feathers on the forehead and some of the upper wing-coverts have pinkish-white edges, the upper side has a decided rufous wash and the grayish ochre wash of the under side is much reduced.

DESCRIPTION OF THE TYPE (No. 225221).—Crown, hind neck, back, scapulars, and rump cinnamonous brown (Saccardo's Umber, R. XXXIX), forehead lighter; lores whitish; sides of head sandy cinnamon; upper throat whitish with a pinkish buff wash; lower throat and upper breast ochraceous salmon, more grayish ochre on the sides of the breast; upper belly light salmon-orange, lower belly, under tail-coverts, and flanks whitish with a slight pinkish wash; wings dark brown, upper wing-coverts with cinnamon-brown tips; secondaries with tawny-ochraceous edges, narrow ochraceous-buff bar across the outer webs of the sixth to tenth primaries; broader and somewhat lighter bar across the outer webs of the secondaries, broad white bar across the inner webs of the secondaries and some of the primaries; tail-feathers blackish brown with narrow buffy edges; outermost pair of tail-feathers with buffy white mark of about the same extension as in the male.

FIRST-YEAR PLUMAGE (male and female).—Practically identical with the adult female plumage, differing only in the shape of wing-feathers and tail-feathers, and in the ochraceous margins on the primary-coverts.

NESTLING.—Similar to that of *polymorpha*, but differs in having a lighter and more cinnamonous upper side, in a more brownish (not blackish brown) wing and tail, and in having the edges of the wing-coverts and the cross bar on the upper side of the wing tawny ochraceous, not partly whitish.

Culmen, (in adult males), 13.5–14; tarsus, 16–17.

	WING	TAIL
11 ♂ ad.	59–61 (59.9)	37–40 (38.8)
5 ♀ ad.	58–59 (58.4)	38–39 (38.4)

RANGE.—Bougainville Island, Solomon Islands.

Some of the adult males wear a plumage that might be regarded as somewhat "retarded." The feathers on the throat have in these specimens grayish bases and only the tips are blackish, the upper parts are not deep black, but sooty black, the feathers on the forehead are mixed with blackish, and the edges of the secondaries and the flanks are washed with ochraceous. Otherwise these specimens show every character of maturity.

One specimen is albinistic (No. 225217). Its chin and upper throat are white, bordered with a black line; there are a number of white or pinkish feathers on the sides of the head, on the crown, and on the hind-neck, and there are also some whitish feathers (one primary-covert and

one secondary) in the left wing. The testes are indicated as "large" on the label.

The individual variation found in the females is very much of the same type as described from *multicolor* (see p. 2), but not quite so pronounced.

***Petroica multicolor kulambangrae*, new subspecies**

TYPE.—No. 219373, Amer. Mus. Nat. Hist.; ♂ imm.; Kulambangra Island, Solomon Islands; October 13, 1927; R. H. Beck.

ADULT MALE.—Apparently indistinguishable from those of *P. m. polymorpha* and *septrionalis*.

ADULT FEMALE AND IMMATURE MALE AND FEMALE (first-year plumage).—Similar to the equivalent plumages of *septrionalis*, but having the upper side much more reddish (approaching Mars brown, R. XV) without the cinnamon-sandy tinge of *septrionalis*; the under parts are also much more reddish, particularly in males of the first-year plumage, which have the breast between peach-red and scarlet (R. I). There is very little individual variation.

The immature male differs from the adult female in this subspecies, aside from the usual characters of immaturity on the wing, in the more strongly rufous tinge of the upper parts, in the brighter scarlet of the under parts, in the broader ochraceous edges of the secondaries, and in the more pronounced ochraceous bar across the upper side of the wing.

	WING	TAIL
2 ♂ ad.	60, 60	40, 40
4 ♂ imm.	59–61 (60.0)	38–41 (39.2)
2 ♀ ad.	59, 60	40, 40
1 ♀ imm.	59	38

RANGE.—Kulambangra Island, Solomon Islands.

All the specimens were collected in October and are in fairly fresh plumage. No bird shows any signs of molting.

Plumages in Petroica multicolor

The study of the plumages in this species is of particular interest. It shows that we have to distinguish between progressive and retarded plumages as characters either of geographical or of individual variation. I have discussed in detail the occurrence of such plumages in one of my recent papers (Amer. Mus. Novit., No. 666), but several additional points must be discussed in connection with my studies on the plumages of *Petroica*.

In order to simplify a review of my findings, a few words on the normal plumages in *Petroica* may be of advantage. The typical adult male is black on the upper side, and on the under side almost unpigmented with a rich scarlet coloration. The typical adult female is brown-

ish above, and below dull pale scarlet with a distinct ochraceous wash. This pronounced sexual dimorphism can be decreased either by the male assuming a female-like plumage, or the female assuming a male-like plumage.

STYLES OF SEXUAL DIMORPHISM

<i>Petroica multicolor</i>	<i>feminina</i> <i>soror</i>	<i>multicolor</i> <i>kleinschmidti</i> <i>becki</i> <i>ambrynnensis</i> <i>similis</i> <i>septentrionalis</i> <i>kulambangrae</i>	<i>pusilla</i> <i>polymorpha</i>
♂ ad. ♀ ad.	○ retarded ○ typical	● typical ○ typical	● typical ● progressive

Of the eleven subspecies of *multicolor*, seven have the normal degree of sexual dimorphism, but four have it diminished, either by a change in the male plumage (*feminina* and *soror*) or by a change of the female plumage (*pusilla* and *polymorpha*). It is the same type of variation that we find in the genera *Pachycephala*, *Cyornis*, and probably many other genera of birds, although very little investigating has yet been done with this problem in mind.

The important point—particularly important in view of the recent work on feather physiology—is that the feather follicles of the various races apparently react differently to the sex hormones. It seems obvious that the feather follicles in *Petroica* are more independent of the sex hormones than they are in *Gallus*.

Retarded and progressive plumages occur in *Petroica* as characters not only of geographic variation, but also of individual variation. I have described a good many specimens of that kind on the preceding pages. They all seem to confirm the opinion that I expressed in my latest paper on this subject: namely, that the development of these plumages is largely independent of the development of the gonads.

I have quoted A. Miller in my recent paper for the opinion that the type of a feather was closely correlated with the condition of the gonads during the time of the development of this feather. Still more specific about this is Verwey (1930, Jour. f. Ornith., LXXVIII, p. 234). The opinion held by many ornithologists is that adult or intermediate feathers in an immature bird are directly caused by hormonal influences during

the growth of these feathers. Contrary to this, I have developed in my latest paper the opinion that the change from an immature to an adult feather type is largely independent of gonadal influences, at least in the species without a nuptial plumage.

A study of the recent literature of experimental physiology shows that the tendency to neglect the genetic constitution of the feather follicles, which culminated around 1927, is gradually being overcome. It is now suspected that even in the fowl the feather follicles of male and female have different potentialities. However the hormonal thresholds are so similar that it needed a special technique to discover this. (See Masui, 1933, Roux' Archiv, CXXVIII, pp. 1-14).

What is true for the sexual dimorphism also holds true for the age dimorphism and the differentiation of feather follicles. It may be of interest to the ornithologist who is not familiar with the literature on experimental zoölogy, to quote some of the recent writers on this subject: "Up to the present time the type of feathering, as regards secondary sexual characteristics, has been believed to be wholly under endocrine control (Lillie, 1927, Jour. Exper. Zoöl., XLVIII, pp. 175-196). Nevertheless the [skin] graft from a brown Leghorn female to a barred Plymouth Rock male produced cock feathers in advance of the host, and the graft from a Plymouth Rock male to a Minorca male produced cock feathers later than the host, but earlier than the donor [of the graft]. . . . The time at which a young fowl assumes its adult plumage may depend not alone on the establishment of a certain endocrine balance, but also upon the age at which the feather follicles become responsive to particular stimuli" (Danforth, 1929, Genetics, XIV, p. 268). In another paper Danforth shows that the feather follicles may react differently to hormonal influences even in closely related breeds of fowl: "These results may be readily interpreted on the assumption that it is primarily the tissues and not the hormones which determine effects. Hormones have probably remained essentially the same throughout the phylogeny of vertebrate classes, since those of mammalian elaboration are known to be readily utilized by such forms as birds and amphibians. In a number of forms . . . sexual dimorphisms in plumage . . . are dependent for their realization on particular endocrine environments of the feather follicles. But some other forms have not acquired the capacity to respond differentially to these factors in their internal environment. . . . In one case, a hormone may seem to be a very potent agent, in another a quite inert substance. The experiments show that different [domestic] races of a single species may exhibit very different responses to the same hormone"

(Danforth, 1933, Jour. Exper. Zoöl., LXV, p. 192). The conditions in the genera *Petroica*, *Pachycephala*, and *Cyornis* are of almost the same nature as those described by Danforth from the domestic fowl, only much more pronounced.

There is additional evidence concerning the age in which individual feather follicles produce specific patterns, and the investigation of the sequence of patterns may have some evolutionary significance. Dunn and Landauer studied a breed of Hamburg fowl which is "silver spangled" in its adult plumage, but shows "cross pencilling" in immature feathers. They say: "The observation of a specific pattern (cross pencilling) which appears early from the same follicles which later produce spangled feathers is interesting since this pattern characterizes the adult feathers of the "Pencilled" Hamburg variety and is apparently a primitive type distributed throughout gallinaceous birds. . . . The chief ontogenetic significance of such differences between successive feathers, however, is in demonstrating the wide range of responsiveness of the feather follicles during early growth" (Dunn and Landauer, 1930, Storrs Agric. Exper. Station, Bull. 163, p. 45). The study of the responsiveness of feather follicles in the period between immaturity and maturity seems to promise very interesting results. Kuhn (1932, Roux' Archiv, CXXVII, pp. 502-519) has done a great deal of work on this problem, but new lines of research have been opened up since the injection of hormone extracts has become possible. It is now possible—at least in the fowl—to determine for every part of the body when the feather follicle enters the adult condition, as shown by its response to the female hormone: "The female hormone consistently determines the development of female plumage in the male [Brown Leghorn fowl], but only at such a period [of age], when the potentiality of female feathering as such has become differentiated within the feather germ" (Juhn, Gustavson, and Gallagher, 1933, Jour. Exper. Zoöl., LXIV, pp. 133-186).

